Claims

1. A method for measuring an amount of peroxide or peroxyl ion of a sample comprising the following steps:

(a) irradiating at least a portion of the sample with a laser light for generating a Raman spectrum of the sample;

(b) obtaining at least two measurements at two different wavenumbers from the Raman spectrum, a first measurement related to a Raman intensity related to an amount of peroxide or an amount of peroxyl ion, the second measurement related to the other of the amount of hydrogen peroxide and the amount of peroxyl ion; and

(c) formulating a relationship between a Raman intensity for hydrogen peroxide and a Raman intensity for the peroxyl ion by comparing information related to the two measurements for determining the amount of peroxide or peroxyl ion.

2. A method as defined in claim 1 wherein the relationship between the Raman intensity for peroxide and the peroxyl ion is at least one of a product, a ratio, and a sum of the two measurements.

3. A method as defined in claim 2 further comprising the step of varying the amount of peroxyl ion by varying a pH of a solution.

4. A method as defined in claim 3 wherein an extent of bleaching is determined from the relationship, said extent of bleaching being related to an amount of peroxide or peroxyl ion.

5. A method as defined in claim 3 wherein an extent of ionisation of peroxide is determined from a non-linear relationship including a ratio between the Raman intensity of peroxide and the peroxyl ion.

6. A method as defined in claim 2 wherein the Raman intensity for peroxide is obtained at approximately 875 cm^{-1} and the Raman intensity for the peroxyl ion is obtained at approximately 850 cm^{-1}.

7. A method as defined in claim 2 wherein a characteristic of a pulp or pulp effluent is determined from the relationship, said characteristic being one of pulp brightness, pulp yellowness, and bleaching efficiency.

8. A method as defined in claim 7 wherein the characteristic is related to at least one of an absorption and scattering of pulp or textiles.

9. A method as defined in claim 7 further comprising the step of adjusting an amount of peroxide for obtaining a predetermined amount of peroxide for adjusting the characteristic of the sample.

10. A method as defined in claim 2 wherein the relationship is obtained by applying regression and chemometric methods.

11. A method for determining a property of a sample comprising the steps of:

(a) irradiating at least a portion of the sample with a laser light for generating a Raman emitted light from the sample;

(b) obtaining at least two measurements of the Raman emitted light between 200 cm^{-1} and 4000 cm^{-1}, a first measurement at a first wavenumber and a second measurement at a second wavenumber; and

(c) determining a non-linear relationship between the at least two measurements and the property of the sample.

12. A method as defined in claim 11 wherein the non-linear relationship is determined by regression methods.

13. A method as defined in claim 12 wherein the non-linear relationship is expressed as at least one of the following functions between the property of the sample and the first and second measurement:

property of sample = f (first measurement, first measurement / second measurement);

property of sample = f (first measurement, first measurement * second measurement);

property of sample = f (first measurement, first measurement / first measurement + second measurement); and

property of sample = f (first measurement, first measurement + second measurement / first measurement).

14. A method as defined in claim 12 further comprising the steps of obtaining at least third measurement of the Raman emitted light between 200 cm^{-1} and 4000 cm^{-1} and determining a non-linear relationship between the at least three measurements and the property of the sample.

15. A method as defined in claim 14 further comprising the step of formulating at least two ratios from the at least three measurements.

16. A method as defined in claim 13 further comprising the step of controlling the property in a process using feedback control for adjusting at least one feed input component in accordance with a determined value of the property for obtaining a predetermined value of the property.

17. A method as defined in claim 16 wherein the sample is produced by one of a wood pulp bleaching process and a wood pulp delignification process.

18. A method as defined in claim 16 wherein the property is one of an equilibrium property, a property that occurs due to competitive processes where relative rate constants are important, and a property that signifies an extent of a reaction.

19. A method as defined in claim 18 wherein the property is one of pulp bleaching and pulp delignification.

20. A method as defined in claim 18 wherein the property that signifies the extent of the reaction is a degree of polymerisation.

21. A method as defined in claim 18 wherein the property is one of a degree of polymerisation, ionisation, and network formation of a silicate solution.

22. A method as defined in claim 18 wherein the property is related to an amount of organic substances in the sample, said property being one of chemical oxygen demand, biological oxygen demand, and total organic carbon.

23. A method as defined in claim 18 wherein the property is one of an amount of ionised species and a charge density.

24. A method as defined in claim 18 wherein the property is related to a propensity to form scale.

25. A method as defined in claim 18 wherein the property is an oxidation reduction potential of the sample or another measure of the oxidative or reductive capacity of the sample.

26. A method as defined in claim 18 wherein the property is a relative amount of a transient species with respect to either a reactant or a product during a chemical reaction or processing step.

27. A method for determining a potential of an oxidative reductive process comprising the following steps:

(a) irradiating at least a portion of the sample with a laser light for generating a Raman emitted light from the sample;

(b) obtaining at least two measurements of the Raman emitted light between 200 cm^{-1} and 4000 cm^{-1}, a first measurement at a first wavenumber, and a second measurement at a second wavenumber; and

(c) determining a relationship between the two measurements and the potential of the oxidative reductive process.

28. A method as defined in claim 27 wherein the at least two measurements are Raman intensities and wherein at least one of the intensities is an intensity peak.

29. A method as defined in claim 27 wherein the relationship includes at least a ratio based on the two measurements.

30. A method as defined in claim 29 wherein the relationship is derived from a Nernst equation.

31. A method as defined in claim 29 wherein the sample includes molecules with elements that exist in one of a plurality of oxidation states.

32. A method as defined in claim 31 wherein the elements include nitrogen, sulfur, phosphorus, chlorine, manganese, and chromium.

33. A method as defined in claim 31 wherein the molecules include sulfides, cyanides, chromates, and nitrates.

34. A method as defined in claim 31 wherein the molecules are substances for one of bleaching pulp, textiles, and food substances, said molecules including sulfite, chlorine dioxide, chlorite, and hydrogen peroxide.

35. A method for measuring an amount of at least one of hydrogen peroxide and peroxyl ion (HOO^-) in a solution, comprising the steps of:

irradiating at least a portion of the solution with light of a suitable wavelength and intensity to obtain information relating to a Raman spectrum thereof, said information containing data related to at least one of an intensity peak corresponding to peroxide and an intensity peak corresponding to peroxyl ion; and,

processing the information to determine indicia of a concentration of at least one of hydrogen peroxide and peroxyl ion, the processing including an analysis of at least one of data related to the intensity peak corresponding to peroxide, data related to the intensity peak corresponding to peroxyl ion, a sum of data related to the intensity peaks of the peroxide and peroxyl ion, a product of data related to the intensity peaks of the peroxide and peroxyl ion, and a ratio of data related to the intensity peaks of the peroxide and peroxyl ion.

36. An apparatus for determining a property of a sample comprising:

a laser light source for irradiating at least a portion of the sample for generating a Raman emitted light from the sample;

a detector for detecting the Raman emitted light from the sample, said detector for obtaining at least two measurements of he Raman emitted light, a first measurement at a first wavenumber and a second measurement at a second wavenumber; and

a processor for receiving and processing data from the detector for determining a non-linear relationship between the at least two measurements and the property of the sample.

37. An apparatus as defined in claim 36 wherein the non-linear relationship is determined by regression methods.

38. An apparatus as defined in claim 37 wherein the non-linear relationship is expressed as at least one of the following functions between the property of the sample and the first and second measurement:

property of sample = f (first measurement, first measurement / second measurement);

property of sample = f (first measurement, first measurement * second measurement);

property of sample = f (first measurement, first measurement / first measurement + second measurement); and

property of sample = f (first measurement, first measurement + second measurement / first measurement).

39. An apparatus as defined in claim 38 further comprising a member for controlling the property in a process using feedback control for adjusting at least one feed input component in accordance with a determined value of the property for obtaining a predetermined value of the property.

40. A system for determining a property of a sample comprising:

means for determining a non-linear relationship between at least two measurements and the property of the sample, the at least two measurements corresponding to Raman emitted light between 200 cm^{-1} and 4000 cm^{-1}, and the at least two measurements comprising a first measurement at a first wavenumber and a second measurement at a second wavenumber.

41. A system for determining a property of a sample comprising:

means for comparing at least two measurements including a first measurement at a first wavenumber and a second measurement at a second wavenumber, the at least two measurements corresponding to Raman emitted light between 200 cm^{-1} and 4000 cm^{-1} when the sample is irradiated with a laser;

means for determining a non-linear relationship between the at least two measurements and the property of the sample; and,

means for determining the property of the sample in dependence upon the non-linear relationship.

42. A system for determining an amount of at least one of hydrogen peroxide and HOO- in a solution, comprising:

means for receiving information containing data related to at least one of a Raman intensity peak corresponding to peroxide and a Raman intensity peak corresponding to peroxyl ion; and,

means for processing the information to determine indicia of a concentration of at least one of peroxide and peroxyl ion, the processing including an analysis of at least one of data related to the intensity peak corresponding to peroxide, data related the intensity peak corresponding to peroxyl ion, a sum of data related to the intensity peaks of the peroxide and peroxyl ion, a product of data related to the intensity peaks of the peroxide and peroxyl ion, and a ratio of data related to the intensity peaks of the peroxide and peroxyl ion.

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